# III.

## Extracts from Reports by Mr. Gustav Mann, Assistant Conservator of Forests, Bengal.

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### SCOTCH FIR FORESTS OF LÜSS, BEECH FORESTS OF THE DEISTER AND SOLLING, SPRUCE FORESTS OF THE HARZ.

Cultivation and general management of the "Lüss" Scotch fir forests.

At the Lüss forests, and especially near Niebeck, I received instructions in the very extensive and most successful cultivation of the Scotch fir, as well as in the general management of these forests.

In the plains of North Germany the Scotch fir is the principal forest tree, and better suited for deep, loose, and sandy, than for heavy, loamy soil; it gives a fair amount of timber, and from these forests is chiefly applied for local building and other purposes.

The branches and rootstocks are used either for the burning of charcoal or as firewood.

Situation of the Lüss forests.

The Lüss forests are situated about half way between Hanover and Harburg, and constitute part of the great "Lüneburg Heath."

It is that portion of the province of Hanover in which the forests are most extensive, although from causes similar to those which tend to destroy some of the Indian forests, viz., the indifference of the inhabitants to the existence of forests, originating in the common belief that they will continue to exist, no matter how recklessly treated, the desire of the villagers to get grazing ground for their cattle by burning the forests, the indiscriminate usage of the wood, and method of felling in vogue, hundreds of miles of forest have been destroyed in former time, and have left the greater part of the "Lüneburg Heath" barren, covered almost exclusively with heather, and of little use to any one.

It is with a view of restoring these forests that at present much skill and labour, as well as large amounts of money, are being spent in getting up new forests.

Cultivation on land with a subsoil of moorpan.

For the successful cultivation of the Scotch fir in the Lüss forests the moorpan, so prevalent in these plains, had frequently to be broken through.

Near Niebeck alone there are about 1,000 acres brought thus under cultivation, and nearly all within the last three years.

This area was generally broken up in strips, eight feet wide, leaving between strips of six feet in width untouched.

This was done partly by ploughing where necessary to a depth of two feet, and in places where even this was not sufficient to break through the moorpan, it was done with the spade by men trenching the soil.

The average cost of thus preparing the soil for these plantations has been 18*s.* 3*d.* per acre, which would be very high if it was not considered that by so doing the soil was redeemed for cultivation.

The material for planting consisted of one-year old seedlings of Scotch fir, and occasionally a two-year old seedling of spruce, which are raised in the ordinary way by sowing in furrows.

The planting is done with a wedge spade, which is constructed in one piece out of beechwood, shod with iron, and 3′ 4″ long from the handle to the edge.

The blade alone is 11½″ high, half as broad, and 2″ thick at the top (Fig. 1.)

Fig. 1.

With this spade one man proceeds along the prepared strip or bed, making holes at distances 3′ × 5′ by simply treading the spade into the soil, and he is followed by two women, who plant by holding the young seedling firmly with their left hand against one side of the hole, whilst with their foot they press the soil from the opposite side towards the plant.

The average cost of such planting has been about 5*s.* 8*d.* per acre.

Where sowing was adopted instead of planting the ploughed or trenched strips were first levelled with a harrow, and after this the seed sown at an average cost of 1*s.* 4*d.* per acre, 3 lbs. of Scotch fir and 1 lb. of spruce seed being used for sowing one acre, the cost of which is not included.

The filling up of vacancies afterwards came to 1*s.* 6*d.* per acre, and the average of the total expenditure of getting up these plantations was 1*l.* 5*s.* 6*d.* per acre.

These forests are of greater value by being situated alongside of the Hanover and Harburg line of rail, as the thinnings and so forth are readily disposed of; but by this they are also placed in great danger from fire during hot and dry summers, since the sparks flying from the engine often light

the accumulated fir leaves, dry heather, and other smaller plants.

Protection of forests against fire.

To guard against this danger, so called "safety strips" of other kinds, not conifers, are planted along the line of rail, as, for instance, birch, coppice wood of oak, &c.

Something similar might be carried out in India, with a better chance of keeping out fires than there is at present, and at reasonable cost.

Danger to forests from insects.

I had frequent opportunities of witnessing the damage done to the Scotch fir forests by insects, and the means adapted to prevent or diminish it where possible.

Whilst the young trees suffered most from the larvæ of may-bug (*Melolontha vulgaris*), and a little beetle (*Curculio* (*Hylobius*) *pini*), the old trees were frequently destroyed by beetles (*Bostrichus*), attacking the bark which necessitates occasionally the cutting down of whole forests, since wind and storms, admitted through the open spaces caused by the attack of the beetles, would soon overthrow the rest of them.

Caterpillars also frequently damage the young Scotch fir by eating the leaves, thus making the plants sickly, and rendering them more liable to attacks from other insects.

General management of Scotch fir forests.

The Scotch fir requires more light and air than any other, and does not thrive at all in the shade of other forest trees.

For the same reason natural reproduction is very difficult, and only practicable under very favourable circumstances, and not attempted here, where it is grown in regulated forests with complete clearances and re-stocked by sowing or planting.

As a tree affording some shade to other kinds who require it the Scotch fir is well suited.

If sown or planted very close early attention to thinning out is also necessary, as plants early stunted never fully recover their strength.

The soil not being rich the trees are not allowed to grow older than 60–80 years, this being the age at which the comparative yield of wood is the best.

For the production of large timber the soil is not good enough, and therefore this is, as a rule, not attempted.

The holding over of a few selected trees to grow as many years again with the succeeding generations is not advisable in these forests either, as the storms and winds are too violent.

Fellings of the Scotch fir, as of all other kinds, are proceeded with from east or north-east to west or south-west, to secure the shelter of the old forest, which remains standing.

As before mentioned, spruce is planted in small number with the Scotch fir, and even where the soil is not good enough for it to grow up into large trees with the Scotch fir it becomes beneficial to the latter by the cover it affords to the soil through its denser foliage, thus facilitating decomposition of the soil, and keeping it moister and cooler than the Scotch fir alone would be able to do.

Manufacture of charcoal.

The making of charcoal in the forests is kept up to some extent, not that much revenue is derived from it, but it covers the expense of getting the stumps out of the ground and the branches collected, whereby danger from insects is removed, as this old wood is their chief breeding place, besides the loosening and clearing of the soil afforded by the digging up of the former.

I took this opportunity of getting instruction in charcoal burning, in which economy is sadly wanted in India, especially in the tea districts.

Nienburg Scotch fir forests.

At the Nienburg forests, to the north-west of Hanover, which also consist chiefly of Scotch fir, I received instructions in the cultivation and management of forests in low situations.

As the Lüneburg forests are remarkable for their dryness and the general want of moisture and water, so are these particularly instructive on account of their low, swampy character.

Cultivation and drainage of swampy forests.

Drainage is the only way by which such ground can be made fit for forest growth, and has often to precede by several years the planting, since the ditches cannot be made sufficiently deep at once, as they would soon be filled up again by the falling in of the sides.

A regular network of ditches, distributed over the ground after a well-considered plan, as well as the spreading of the soil taken out of the ditches over the surface of the beds between, are the ordinary means of rendering such localities fit for cultivation.

Previous turning over of the soil is here as everywhere followed by superior growth, justifying it whenever the funds are available.

Spruce in exceptionally wet places were even planted on the top of the soil, and their roots surrounded with earth, which answers admirably.

Moorpan in wet localities is not found quite so troublesome as in dry, but repays here also the expense and labour of breaking through it.

The general appearance of young Scotch fir on these beds between the trenches was very promising, whilst the

same tree on simply harrowed ground looked very healthy, but without the same vigour, showing that by the digging of the soil the plants gain several years.

Deister and Solling Hill beech forests.

At the Saupark forests, on the Deister Hills, I received instruction in the cultivation and treatment of beech forests, which studies I continued also on the Solling Hills.

Both localities are south of Hanover, and contain some of the richest forests in the province.

Use of the beechwood.

The beech is very extensively grown in Germany on account of the great value of its wood as fuel, for which it is chiefly used.

As timber it has been found to answer for shipbuilding, railway sleepers, the manufacture of furniture, cartwright work, and many other minor purposes.

Improvement of the soil by the beech.

No tree is more adapted for keeping up the quality of good forest land and for improving inferior soil than the beech, and it is cultivated wherever the soil and the climate permits.

It ascends in North Germany to a height of about 2,000 feet, above which elevation its cultivation ceases to be remunerative.

Lime and red sandstone hills like these are best suited for the beech, and allow it to attain great perfection.

Raising beech forests by sowing and planting.

Seed beds for beech are prepared in the ordinary way, and the seed is sown in autumn as well as in spring.

If the former time is preferred care has to be taken that the seed does not germinate too early, so as to be exposed to spring frosts; this is prevented by covering over the beds after the surface gets slightly frozen, and by removing the covering in spring so late that the young seedlings have nothing more to fear from the frost.

If sown in spring the seed has to be carefully stored during the winter. Steaming, as well as excessive drying, must be guarded against; the first is avoided by turning over the seed or even keeping it spread out; the second by slight watering it and turning it over afterwards, so as to distribute the moisture equally.

A cool moist room on the ground floor is preferable to a warm and dry one.

From the seed beds the plants are either removed at once into the forest or into other nurseries for transplanting, and keeping until they reach a height of 3–4 feet.

If they are to be planted in open ground, without the protection of old trees, they are sometimes kept in the nursery until they reach a height of 10–12 feet, which how-

ever is a very expensive measure, and only adopted in exceptional cases.

In this case care is taken that the young shoots are not removed from the stem, as the bark of the beech is very easily burnt by the sun, and otherwise apt to be damaged by the weather.

Unnecessary exposure of the roots of the young beech is carefully avoided, as they are very sensitive, and demand special care during the removal of the plants.

Where it can be done, some of the soil is left on the roots for the same reason.

Natural reproduction in beech forests.

Ordinarily the beech forests here get re-established by natural reproduction, *i.e.*, the shedding of seed from old trees.

Where the beech occurs mixed with other kinds, as in the coppice with standards, its regeneration is furthered or checked according to circumstances, but planting is seldom resorted to.

In the pure high forests of beech the natural reproduction is brought about by gradual and well considered fellings, which tend to effect this as completely as possible. In hilly or mountainous localities fellings are commenced at the top of the hill.

These fellings take place when the trees have reached maturity, and are 3–4 in number, and distinguished according to the immediate effect they are intended to have on the forest.

The preparatory cutting.

The first felling, called in Germany the preparatory cutting (*Vorbereitungs hieb*), is intended to facilitate the decomposition of the dry leaves and branches which cover the surface, and thus prepare it for the reception of the seed, which latter, without this precaution, frequently germinates without being able to penetrate with its roots the comparatively hard and leathery leaves lying on the surface, and often dies in consequence, whilst weeds and scrub easily get up in it, and cover the surface soon, thus adding to the difficulties to be overcome by the young plants.

It is commenced several years before the intended regeneration, and carried out gradually, but where the air and light thus admitted is not sufficient to render the surface fit for the reception of the seed, a timely permission to villagers to remove some of the dead leaves is resorted to.

Besides the preparing of the soil, this opening out of the forest induces the tree to flower and bear seed more frequently than when standing very close.

The seed cutting.

The second felling, the so-called seed cutting (*Samenschlag*), is carried out as soon as the bearing of seed becomes probable, which can be judged of beforehand by the appearance and the shape of the buds during the preceding winter.

An abundant seed-bearing season generally occurs with the beech after longer or shorter intervals, but sufficient seed for the regeneration of the forest may be reckoned on every second or third year.

Precaution is used not to remove too many trees at once, as in case of the flowers being destroyed by spring frosts or from other causes, the restocking of the ground with young plants does not succeed; too much light would dry up the surface of the soil, and induce the weeds to overrun the ground, both circumstances seriously interfering with the germination of the seed at a future season.

Where at this time the suitability of the soil or a portion of it remains doubtful, a timely loosening and preparing of it in strips or patches is resorted to to ensure success.

Where the expected seeding of the trees turns out a failure further clearing is carefully avoided to prevent the deterioration of the soil or overgrowing with weeds; if, however, the season is a favourable one, and produces sufficient seed, and the young plants germinate, this felling is soon extended to a greater number of trees, to admit more light and dew to strengthen the young plants.

For the purpose of getting the seed worked into the ground, herds of swine, cattle, etc., are often driven through the forest with good results.

Seed beds are sometimes established in the neighbourhood of a forest at the same time to furnish young plants for the filling up of vacancies, which, however, are also obtained nearly as good out of the forest itself from places where the plants stand thick enough to admit of it.

Altogether the aiding of the natural reproduction by artificial means, either sowing or planting, is at the present time generally resorted to at once, as such measures always lead to a more satisfactory accomplishment of the desired regeneration, and save time.

The amount of light to be admitted by this felling varies greatly according to soil, position, if in the plains or in the hills, and the exposure of the forest.

Success of the natural reproduction in the beech forest must vary therefore greatly with the judgment and discretion of the forester, as he has to adapt the treatment of the forest to the circumstances of the case.

Natural reproduction seems to require especial care on southerly and westerly slopes, where the sun has greater power, and dries up the surface of the soil much sooner, and lets the weeds grow much faster, if clearances are made to the same extent as on level ground, or on northerly and easterly exposures.

I had several opportunities of witnessing cases where, on southerly slopes, year after year new attempts were made to stock the hill sides with beeches without succeeding, and at last the spruce, or even Scotch fir, had to be resorted to instead of the beech to make use of the ground.

The third felling is called cutting for light (lichtschlag), as its chief purpose is to admit light and air in greater abundance as the young trees require it. The cutting for light.

This is generally commenced when the seedlings are two years old. It is also regulated very much by circumstances, and whilst in the one case the parent trees may be required longer on account of the spring frosts, so injurious to the young beech, in others their early removal is necessary, even if an increase in size be sacrificed, for the establishment and vigorous growth of the young trees.

Neither do partial failures prevent the removal of the old trees, but are adjusted at once by sowing or planting as the safest and most expeditious mode of securing the establishment of the young forest.

After the third or light-felling follows the gradual removal of the old trees, or final clearing, which is regulated in the first instance also by the requirements of the young trees, and after this by the fixed yearly out-turn, as laid down in the working plan, and other circumstances. Final clearing.

As a general rule all these fellings are carried out gradually without causing sudden changes in the forests.

The aiding of natural reproduction is either accomplished by sowing, if failures are perceptible at the early stages of it, such as insufficient germination of the seed, or early dying of the seedlings, or by planting, if the seedlings get destroyed later by spring frosts, or are choked by weeds. Aiding of natural reproduction.

The sowing is carried out in the forest on strips two feet wide, in furrows, or on patches 2–3 feet square, prepared by hoeing for the purpose, and by loosening and levelling of the soil, whilst planting is done with seedlings 2–3 feet in height, taken from adjoining nursery beds, or from spots in the forest where there are more than are necessary.

It is evident that if with all this great care and attention to aid natural reproduction, still occasional failures occur, how much more unreasonable it is to expect forests in India

to keep in an equally rich and thriving condition, if left to themselves, or worked only with a view of extracting the timber from them.

Pure high forests of beech.

No mode of growing the beech suits it better than in high pure forests, it liking the deep shade and coolness of the soil, which its dense foliage secures for it, and improving the soil more than any other forest tree, by the abundance of leaves shed every autumn, forming a rich vegetable mould, and facilitating the decomposition of the mineral and vegetable substances in it.

Such forests are allowed to grow in a rotation of 80–120 years before the regeneration or final clearing is carried out whilst all thinnings previous to this, are considered as the result of measures for the improvement of the forest, the object in undertaking them being to improve the condition of the remaining trees.

The general rule is to repeat thinnings often, and to remove little at a time.

"*Conservations-hieb*" introduced by Forstmeister Seebach in the Solling forests.

I had also an opportunity of seeing a modified form of beech high forest, in which at an age of about 60 years, a large number of the trees were felled and removed, whilst the new covering of the soil for the benefit of those left standing was accomplished by again sowing beech underwood amongst them which had much improved the old trees left, and resulted in a proportionately rapid increase in size.

The beech in coppice woods.

In coppice woods it occasionally happens that the beech is allowed to remain if it comes up, but otherwise it is not much adapted for this mode of growing wood.

The beech in middle forests.

In middle forests or coppice under standards it is frequently spared by the woodcutter, although not so well suited for high trees in such a combination, as the oak, and other trees which give less shade.

Danger to beech forests from spring frosts.

The greatest danger that beech trees, especially when young, are exposed to, are the late spring frosts, which do great damage, and can scarcely be obviated.

They do most damage in valleys, or other low places, the neighbourhood of water, etc., where there is no current of air.

Danger from sudden exposure to sun.

Another enemy is the sun, which, if beech stems are suddenly exposed to its glare, damages and destroys them rapidly, as I had an opportunity of witnessing, although the trees were about 50 years old.

Other trees in the beech forests.

Not unfrequently trees whose timber is of greater value than that of the beech are scattered in the beech forest, to derive the benefit from the rich vegetable mould formed by the beech, but care is taken, that such trees, when placed

amongst the beeches are sufficiently advanced as not to get choked by the latter.

The trees thus employed are chiefly oak, ash, maple, larch and Scotch fir.

The beech in other forests.

I saw a remarkable instance at Rothenkirchen where beech had been planted under oak of about 120–150 years old, standing on old grazing grounds on which the villagers had been entitled to graze their cattle, and to various other privileges.

After it had been freed from these burdens by the villagers receiving other land, the oaks were stagheaded and altogether deteriorating, when beeches were sown and planted underneath, and these so benefitted the oaks, that they had made new vigorous shoots and become covered with leaves again and were now with the beeches under them in a condition to grow for as many years again as they had done already.

Management of middle forests.

In the Solling hills I had also frequent opportunities of seeing the management of middle forests being coppice under standards.

This mode of growing is here principally adopted by villagers and other communities, who by means of the short rotation of the coppice keep themselves supplied with firewood, whilst the high timber trees have to furnish the wood required for building and other purposes.

Middle forest demands good and deep soil, rich mineral soils being specially suitable, for the improvement, though the wood growing on it is limited, on account of the short rotation at which the underwood is grown, and the comparatively small number of older trees.

Kinds suitable for high timber trees in the middle forest.

The kinds most suitable for high timber trees are those which give the least shade and keep off as little of the dew and rain from the underwood as possible, whilst at the same time they are regulated by the requirements of those who own them.

Generally the better kinds of timber trees are chosen, conifers are not excluded, although of no use as coppice wood.

The kinds used in most cases are oak, hornbeam, maple, ash, birch, and an occasional beech.

Kinds suitable for coppice wood in the middle forest.

As coppice wood, those kinds are most suited which shoot out again easily from the root stock, and stand the shade from above best, as for instance, the hornbeam, maple, beech, oak, birch, and so forth.

The rotation of the latter is generally 30 years, but varies according to soil and locality.

Since underwood and timber trees have to be felled at

the same time the rotation of the latter has to correspond with that of the former, and is either three, four, or five times that of the coppice, so that the timber trees are felled at 90, 120, or even 150 years, or some at each.

Reproduction of middle forest.

At each felling a number of young saplings are saved to replace those timber trees, which are being felled, and as a rule only seedlings are chosen, so that there are timber trees of 30, 60, 90, and 120 years after each felling, if it is intended to grow as large timber as requires 150 years to grow.

Foresters distinguish them by different names according to their age.

The greater the number of timber trees kept, the less can be expected from the coppice wood, and vice versâ, so that the desired crop has to regulate the proportion to each other.

Since every time the coppice is cleared away the ground is laid open to a great extent to the sun and the weather, and but few dry leaves are added for the improvement of the soil, the latter deteriorates very rapidly, if not rich, and it was noticed that foresters as a rule kept rather more timber trees in these forests than the theory admitted, and even in many places endeavoured to induce the communities to take to high forests altogether, which although perhaps not so convenient, still gives a larger return, and keeps the soil in better condition.

The natural reproduction takes place by the shedding of seed from the old trees, and there is usually no lack of seed in such forests, since by the free access of air and light, the bearing of the trees is much facilitated.

By these seedlings, those stocks which die out, get replaced as well.

Where natural reproduction fails sowing and planting is resorted to and is safer in good sized clumps than singly, and where branches cover the lower part of the timber trees they are trimmed off, so as not to interfere with the underwood.

It had been the rule in the communal forests in former times, that any oak which might grow should belong to the state, in consequence of which oaks had become scarce in these forests.

Importance of roads.

The forests on the Solling hills had greatly increased in importance and value in late years by the construction of roads, rendering them more accessible, where the wood had to be carted up hill, a gradient of 8 feet in 100 was not exceeded.

Timber transport, especially that of heavy logs, was managed by means of pulleys, which might with great advantage be brought into more general use in India. Timber transport.

A remarkable instance of privileges enjoyed by villagers, having almost overgrown the quantity produced by the forests, came here to my notice. A remarkable privilege.

The potters of Fredelsloh, a village on the Solling hills, had made the Duke of Grubenhagen, when in camp with his men near their village during winter, very comfortable, by taking all the stoves they had in store up to the camp, and putting them up.

The Duke in return felt grateful, and promised a supply of wood from his forests for burning their tiles and pots, &c. free of charge.

As time went on these potters prospered and multiplied, until at last the forest, although very extensive, could hardly supply what they asked for, when their claims had to be defined as to the number of families entitled to receive wood, and the quantity for each. Since this settlement the forest is beginning to recover.

Of the various methods of planting employed here, there is one which does not seem very judicious at first sight, but has been so remarkably successful that it is worth describing. Planting with an iron spade.

The planting is done with a small spade of solid iron, about 18–20 pounds in weight, the handle of which is 3′ 4″ in length, and strongest immediately above the blade, which latter, slightly wedge-shaped, is 13½″ long and 6¾″ across at its broadest and 4¾″ at its narrowest part (Fig. 2).

Fig. 2.

This spade is driven into the ground on the spot where the plant is to stand, and not quite perpendicular.

The hole thus made with this spade is slightly widened by bending the spade a little to all sides, after which it is drawn out.

The plant, 3–4 years old, of beech, spruce, oak, &c., is dipped with its roots into a thin mixture of loam and water, which adheres easily. In this state it is pushed with its roots into the hole as far as possible, and with continual shaking, by which the roots get straight down into the hole, drawn up to the level at which the plant is to stand.

Here it is held firmly by one man, whilst another drives in the spade a second time, about three inches from the first hole and parallel with it, and first presses with its point towards the first hole, and afterwards with the broader portion of the blade, by which process the plant gets very firmly pressed into the soil.

If necessary the spade is driven in a third time to close up the second hole slightly.

After this the soil is beaten firm all round with a wooden mallet towards the plant, but these blows should not be dealt closer than three inches from the plant.

This planting was carried out without previous clearing or preparing of the soil, and even answers well in stony and rocky soil, as the spade penetrates easily on account of its weight.

Spruce forests on the Harz mountains.

On the Harz mountains I acquired chiefly a knowledge in the management of spruce forests at the following localities in succession :

| | |
|---|---|
| Westerhof. | Herzberg. |
| Grund. | Lauterberg. |
| Osterode. | Ilfeld. |
| Riefensbeek. | |

Seed drying kiln.

At Westerhof, I went over the Government seed drying kiln, for getting the spruce seed out of the cones, and cleaning it of the wings, which is carried on here on an extensive scale, the spruce being plentiful, of excellent growth, and producing exceptionally good seed.

The cones are collected by contract work, and the payment varies according to the seasons, if plentiful or otherwise, and generally enables the workman to earn from 2*s.* to 3*s.* a day.

After all the Government stores are filled, private persons are allowed licenses to collect, for which each person has to pay 1*s.* a season.

In the cones the seed remains good for seven to eight years.

When the kiln is being worked, about 60 bushels of cones are dried out in a day, of which each bushel gives about 1·2 pounds of clean seed, without the wings on the seed.

The Government kiln turns out about 180 cwts. of clean seed yearly, whilst private parties in good seasons have turned out as much as 1,600 cwts. besides.

The cones, when first brought in, are stored in large rooms with perforated walls, so as to admit a free current of air through them.

The kiln itself consists of three rooms, the centre one of which is heated by means of a large oven, from which large iron pipes, about 6″ in diameter, are passed twice through the room before they lead into the chimney.

This room is separated by walls, in which there are holes 9″ from the two outer rooms, in which the cones are being dried.

By means of these holes which can be closed at pleasure, the temperature in the drying rooms is regulated, and kept between 122° and 128° Fahr.

The drying is done in large wire drums, out of which the seed falls on to the floor of the room.

The drums are made so that they can be turned from the outside of the drying room, where it is cooler.

Each of the drying rooms contains 12 drums.

These drums were first filled in the evening, and the temperature got up to about 128° Fahr., and left so for the night. The next morning when some of the seed had fallen out, the fire was lighted afresh and the temperature got up again to the same heat, the drums being turned every half hour, in consequence of which the seed dropped out, and left the cones empty by night.

One half of these empty cones are required for firing the kiln, whilst the other half are sold as fuel.

The cost of the cleared seed is about 3*d.* per pound to Government, at which rate the seed is distributed, whilst the seed not required by Government is sold to the public at the rate of 4¾*d.* per pound.

Spruce on the mountains.

Although the spruce is frequently seen in the plains and on some of the hilly parts of the Province of Hanover, its head quarters are the Harz Mountains, where it does well up to an elevation of 2,500 feet above the sea.

Use of the spruce wood.

Its wood is chiefly used for building purposes, and the larger logs sawn up into planking by the saw mills, besides which there are several wood grinding mills in the Harz, which grind the spruce wood into pulp for paper manufacture, and one mill I visited in which the saw dust from the saw mills was ground down further into wood flour, or dust for paper manufacture.

At the latter establishment saw dust from the saw mills was purchased at the rate of 4¾*d.* the cwt., and it was sold afterwards according to quality.

| | *s.* | *d.* | |
|---|---|---|---|
| No. 1. - - | 2 | 6 | per cwt. |
| No. 2. - - | 1 | 6 | do. |
| No. 3. - - | 0 | 9 | do. |

It is packed in bales, containing about 2 cwt., and measuring 18 cubic feet, or in bags of 1 cwt.

In India, where there is a large consumption of paper, and thousands of square miles are covered with forest trees, producing soft white woods, a similar application of it might be advisable.

Natural reproduction of spruce.

Natural reproduction in the spruce forests on the Harz is seldom attempted, as being too slow and uncertain, but if there are large clumps of naturally sown spruce, they are sometimes kept up.

Raising spruce forests by sowing and planting.

Almost all spruce forests are regulated high forests, with complete clearings, either re-sown, which is still preferred by some, or planted, which is by far the most general mode of establishing or re-establishing spruce Forests.

If sown, lines about two feet in width are prepared by clearing the weeds, &c. off the ground, and placing this at the edge of the lines to prevent the wind blowing away the seed, or rain washing them off.

The soil on these strips is sometimes loosened, or left as it is if the seed is to be sown broad-cast. If the seed is sown in rows small furrows are made.

Between the cleared strips, the ground to double this width remains untouched.

On the hills these strips are always run horizontally along the hill side.

In other cases, only small patches are prepared for sowing, and this is the practice in high and much exposed localities.

For plantations, the seed is sown in seed beds (*Samen-kämpe*) which are good, even, and sheltered pieces of land about half an acre in size and well dug up, afterwards levelled, and occasionally also slightly manured by ashes of the weeds, remains of wood, &c., collected on the surface, brought together, burned, and afterwards mixed with the soil.

These seed beds are usually in the immediate neighbourhood of the ground to be planted and have to be fenced in.

If the seedlings after they are three or four years old are to be removed from here at once to the spot where they are to remain, the seed beds have to be larger, especially if the young plants are to be planted out in numbers, *i.e.*, three or four plants in one hole.

In the latter case the seed is sown generally in furrows, one foot apart, as being more convenient, and requiring

here in the hills about 75 pounds of seed for half an acre, which is sufficient to plant 50 acres of forest.

The better plan, however, is to have the plants from seed beds, after they are two years old, transplanted singly into a nursery at about seven inches distance, where they remain until they are four or five years old, this however requires at least as much space again for the nursery as the seed camp.

Not unfrequently four to six years old seedlings are taken from adjoining forests where they are generally so close as to permit of the removal of many of them, and this is the most inexpensive way of procuring seedlings in limited numbers.

Where there is a great demand for the thinnings of young spruce forests, as well as in high and exposed localities, the planting of three or four seedlings in one hole recommends itself.

If it is likely that the ground gets run over rapidly with weeds or the soil being dried up much by the sun, the replanting of the ground is done as soon after the removal of the old forest as possible, whilst in localities where the danger from insects, especially from the small beetle, (*Curculio pini*) is great, it is preferred to let the ground lie over for two or three years before planting.

Planting is done in autumn as well as in spring, but the latter is preferred.

In these hills the spring planting commences at the foot of the hill and progresses up hill, as the weather improves.

Autumn planting, which becomes necessary on account of short spring time, begins in the end of August, from above, and continues until the end of September at the latest.

Spruce is usually planted 4–5 feet apart and in many different ways, whichever suits the one or other locality best.

On the Bruchberg, about 2,600 feet elevation, I saw very successful and instructive cultivation of spruce on the High Moors. Cultivation of spruce on the high moors.

They were, in the first instance, well drained by a network of ditches, and afterwards the plants placed, not in the soil, but on the top of it, on small mounds of earth prepared on the spot, and the roots surrounded with the same, and afterwards the mound covered in with a few sods of turf.

This operation was expensive and not expected to repay itself during the first rotation, but the whole area was not

only redeemed again for cultivation by it, but the spreading of the moor was prevented.

As the spruce has no deep going taproot, but spreads her roots more along the surface, the cool and damp surface soil of the mountain suits it particularly well.

Under moderate shade, such as for instance the oak and Scotch fir afford, it also thrives well, but its own foliage is so dense that nothing else can be grown under it. It thrives however remarkably well in company of the beech, and then produces exceptionally fine and large timber.

Danger the spruce is exposed to from snow.

At the higher elevations, the spruce is frequently broken down by accumulated snow, especially the young and regulated forests, and there are no means of preventing it except by going back to the old irregular mode of management.

From wind.

Another great danger the spruce is exposed to on account of her roots only spreading in the surface, and for want of a strong taproot, are the storms which had in December 1868 overthrown in some localities trees amounting to seven times the yearly quantum of wood fixed for felling.

This renders great care necessary in deciding the direction in which the felling operations should progress.

From insects.

To protect the spruce forests against damages from insects, the forester has to be constantly on the alert, as they are many and, if not checked in time, great damage is done by them.

The most destructive kind noticed was the ordinary spruce bark beetle (*Bostrichus typographus*) which attacks the bark of living trees, and had in some of the localities visited by me destroyed so many trees that, after the diseased trees had been removed, the forest had become so open that the wind would soon have overthrown the rest if they had not been felled.

Experienced men are told off to guard against this danger, by going through the forest to search for the trees attacked by the beetles, and to fell and bark them, so as to prevent the spreading of the insects, and it is considered they are quite master over them.

They generally attack trees loosened in their roots by wind, and they are easily known after the beetle gets into them by their foliage turning yellow.

In spring, when they are most destructive, healthy living trees are felled at the southern margin of the forests, in sunny spots for the purpose of attracting the beetles.

Such trees are frequently full of them within 3–4 days after having been felled.

The trees attacked by the beetle are barked, whereby the larvæ are destroyed if not already too far advanced; where the latter is the case the bark is collected and burned.

To prevent any of the beetles escaping at the barking of the stem, a cloth is commonly spread under the stem with great advantage.

Another beetle (*Pissodes hercyniæ*) has done great damage in young forests on the Harz mountains, and has to be watched very closely and the trees attacked removed at once.

The timber beetle (*Bostrichus lineatus*) which attacks newly felled trees and penetrates deep into the wood, is also common in the Harz forests, and has to be watched closely.

For the young plantations of spruce the beetle (*Curculio pini*) already mentioned, is the most destructive, as it attacks the young newly planted trees very readily, eats off the bark immediately above the root, and thus kills them.

They are caught under fresh pieces of bark about one foot square, which are distributed over the ground and put with the inner side downwards either before the planting is commenced, or amongst the young trees after it has been completed.

These pieces have to be looked over daily and the beetles collected.

From deer.

The bark of the spruce is also frequently gnawed off by the deer, and places so affected scraped afterwards by men who collect resin.

The latter is prohibited, but in one of the places visited, 100 cwts. were seized the winter before last.

General management of the spruce.

Except in very young and too thickly sown or planted forests, or where other soft wood has sprung up, much thinning out is not required with the spruce, and only those stems should be removed which have got suppressed by the stronger plants.

According to the different altitudes and localities, if more or less suited for it, and the size of the timber most saleable, the length of rotation with the spruce varies from 80–120 years.

Whilst the felling and removal of the timber is done one year, the digging up of the rootstocks for charcoal burning is carried on the next, which latter is also an important measure for the succeeding cultivation of the ground.

Of those trees which grow best with the spruce, the silver fir and the beech are the two most important.

Larch, which formerly was often planted with spruce, has lost much of its importance as a forest tree, on account of its deterioration in this part of Germany.

Charcoal manufacture.

Under former arrangements, great quantities of wood were made into charcoal for the Government silver and iron mines, but when the latter were required to credit the forests with the real value of such charcoal, they soon made other more economic arrangements, and the result has been that coal is now wisely burnt by this establishment.

Roads.

Owing to the extensive manufacture of charcoal, roads for the carriage of timber were less necessary on the Harz than elsewhere, and this circumstance still places some of the Harz forests at a disadvantage.

In the construction of such roads at present, the gradient varies between 3 and 6 feet in 100.

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## SILVER FIR AND SPRUCE FORESTS OF THE BLACK FOREST.

Black forest mountains.

As suggested in the memorandum for the guidance of forest officers, I visited the Black Forest mountains with a view of seeing the management of the silver fir forests on those mountains and the transport of timber as far as such could be of use to me in India hereafter.

For this purpose I went to the Forst revier Rippoldsau, the adjoining districts of the State forests of the Grand-Duchy of Baden, and the Freudenstadt forests in the kingdom of Würtemberg.

On my return from there to Hanover the forests on the Hauptsmoor, near Bamberg, in Bavaria, where the natural reproduction of the Scotch fir is managed very successfully, were also visited.

The silver-fir forests.

The Black Forest mountains are one of the homes of the silver fir, the forests of which, near Rippoldsau, are situated beween 2,000 and 3,000 feet, and therefore at an average height of 2,600 feet above the sea.

The winters are severe, with an average depth of three and a half feet of snow in the valleys from December until March, whilst on the hills the average depth of snow is five to eight feet from the beginning of November until the middle of April.

Management.

They are partly regulated forests, in which, however, a gradual felling for the natural reproduction of them is carried on over one-fourth or one-third of the whole area at once,